The Managers versus the Consultants

E. GRIFELL-TATJÉ	C. A. K. LOVELL
Departament d'Economia de l'Empresa	Department of Economics
Universitat Autònoma de Barcelona	University of Georgia
08193 Bellaterra (Barcelona), Spain	Athens, GA 30602, USA
emili.grifell@uab.es	knox@terry.uga.edu

This is a postprint version of the article that was published in

Grifell-Tatjé, E. And C.A.K. Lovell (2003), "The Managers vs. the Consultants", *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.

DOI: 10.1111/1467-9442.00008

Abstract

Standard practice is to benchmark managerial performance against best observed practice, because engineering information is rarely available. We exploit a rare opportunity to benchmark managerial performance against engineering standards. Our managerial performance describes the activities of Spanish electricity distributors, and our engineering standards are obtained from an engineering grid created by an international consultancy. We find the consultancy's network to be much less costly to operate. When we decompose the cost differential, we find that the superior network design, combined with lower input prices, accounts for more than all of the predicted cost savings. However we also find that the managers are more cost efficient than the consultancy, presumably because they exploit their incentive to be cost efficient under a revenue cap regulatory regime.

Keywords: benchmarking, revenue cap regulation, electricity distribution

JEL codes: L51, L94

Grifell-Tatjé, E. And C.A.K. Lovell (2003), "The Managers vs. the Consultants", *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

The Managers versus the Consultants*

I. Introduction

Variants of revenue cap regulation of monopoly utilities are in use or under consideration in a growing number of countries. The motive is to provide utilities with an incentive to reduce cost through improvements in efficiency and productivity, and to provide regulators with the ability to force utilities to share the benefits with consumers.

The most challenging part of the exercise is the determination of the performance offset X in the revenue cap formula RPI - X, where RPI is a retail price index. In some countries a linear programming technique known as data envelopment analysis (DEA) has been used to benchmark the performance of the regulated utilities against best practice standards. DEA thus allows the regulator to implement a sort of yardstick competition when actual competition is missing. In this way DEA can assist the regulator in the determination of the performance offset X.[1] Kittelsen (1999) and Agrell and Bogetoft (2001) have argued that regulators *should* use DEA to assist in the determination of revenue caps in a wide set of circumstances. They demonstrate that DEA-based yardstick competition can provide performance incentives to utilities, and also can provide the regulator with the ability to capture part of the rents arising from information asymmetries that would otherwise accrue to the utilities.

An equally challenging part of the exercise is the determination of best practice standards. The theoretical benefits of DEA-based yardstick competition notwithstanding, in practice the use of DEA has been hindered in many jurisdictions by small sample sizes caused by a small (and

Grifell-Tatjé, E. And C.A.K. Lovell (2003), “The Managers vs. the Consultants”, *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008
declining) number of regulated utilities. The typical remedy has been to add overseas utilities to the domestic sample, both to expand the sample size and to provide potential benchmarks. The drawback of this practice is that overseas utilities are structured differently, operate in different regulatory environments, and so are rarely comparable.[2]

The second challenge confronts the Spanish regulator. Spain has nine regulated electricity distributors, an insufficient number with which to implement yardstick competition. Consequently the regulator has commissioned an international consultancy to validate a proposed ideal (“referencia”) engineering network. The network is very detailed, technologically and geographically, and enables the regulator to replace inappropriate overseas distributors with a domestic benchmark network specifically tailored to the structure of Spanish electricity demand. This in turn enables the regulator to monitor performance and set tariffs without recourse to the use of controversial overseas benchmarks.[3]

The existence of an engineering network raises the question of how good it really is. Our objective is to use DEA, not in an *ex ante* attempt to determine X, but in an *ex post* comparison of the performance of the distributors with that of the consultancy's ideal network. Our strategy is to benchmark the actual performance of the existing distribution network against the potential performance of the ideal network designed by the consultancy and adopted by the regulator. We measure performance in terms of the operating cost incurred in meeting electricity demand. We decompose the cost differential into three components in an effort to identify the sources of the cost differential. The first component is a network design differential, which we expect to favor the consultancy's more modern network. The second component is an input price differential, which we also expect to favor the consultancy's network. The third component is a cost

Grifell-Tatjé, E. And C.A.K. Lovell (2003), "The Managers vs. the Consultants", *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

efficiency differential, for which we have no expectation. This exercise provides us with an unusual opportunity to benchmark actual performance, not against typical "best practice" standards established in a predetermined sample of actual producers, but against ideal engineering standards established by an international consultancy.

The rest of the paper is organized as follows. In Section 2 we provide some background on the regulation of electricity distribution in Spain. In Section 3 we describe our two data sets. One consists of actual observations on the activities of the distributors in 1996. The other consists of hypothetical observations designed by the consultancy. In Section 4 we propose an economically informative decomposition of the cost differential between the actual distribution network and the ideal network proposed by the consultancy. In Section 5 we show how to implement the decomposition, using DEA. Section 6 summarizes our empirical findings. Briefly, we find the network design differential and the input price differential, both of which favor the consultancy's ideal network, to be partially offset by the cost efficiency differential, which favors the incumbent managers who exploit their incentive to control costs. Section 7 concludes.

II. Background

Prior to 1998 each of Spain's nine regional electricity distributors was vertically integrated between generation and distribution. Following disintegration, six of these companies formed a single group (Endesa), leaving just four independent distributors. The market is heavily concentrated, with the Endesa group and one of the companies (Iberdrola) controlling over 80% of electricity distribution.[4]

Grifell-Tatjé, E. And C.A.K. Lovell (2003), “The Managers vs. the Consultants”, *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

Beginning in 1987 distributors’ tariffs and their capital investment plans were governed by the *Marco Legal Estable (MLE)*. Under this decree distributors’ revenues were determined by their allowed “standard costs." Tariffs were determined by dividing aggregate standard costs by expected demand. This system has worked somewhat like a revenue cap system, since it gave distributors the incentive to reduce their actual costs. The main difference between this system and conventional RPI-X regulation is that, although standard costs have been adjusted upward to account for inflation, they appear not to have been adjusted downward to reflect cost-reducing productivity gains. Moreover, the high level of concentration in the industry, combined with the distributors’ financial and political influence, has limited the ability of the regulator to implement anything like yardstick competition. Thus the considerable benefits of productivity gains realized over more than a decade have been retained by the companies, rather than shared with consumers.

Consequently in 1994 a law (LOSEN) was passed creating a new regulatory body (CSEN), whose main charge was to protect consumer interests and to guarantee transparency of the regulatory process. CSEN planned to overhaul the system of regulation, since the *MLE* remained in effect but had not been updated since 1987. In order to obtain requisite technological and financial information, CSEN sent a questionnaire to all distributors and monitored compliance. The resulting information is contained in an internal CSEN document known as ATLAS, which provides a detailed summary of the distribution network in 1996. At the same time the Ministerio de Industria was considering a rationalization of both the structure of the network and the standard cost framework by which distributor revenues were determined. The idea seems to have originated with one of the distributors, Hidroeléctrica del Cantábrico, which proposed an ideal

Grifell-Tatjé, E. And C.A.K. Lovell (2003), “The Managers vs. the Consultants”, *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

network to the Ministerio and the other distributors. The Ministerio then commissioned an international consultancy to validate the feasibility of the ideal network. The motivation of the Ministerio was apparently the same as that of CSEN, to update the decade-old RPI-0 regulatory system. The Ministerio and the distributors have met periodically since then, in an ongoing effort to reach a final agreement concerning both the structure of the ideal network and a revision of the standard cost framework on which distributors' revenues are determined.[5]

In 1997 another law, “Ley 54/97 del Sector Electrico,” was enacted to introduce competition into electricity generation and to dismantle the vertical integration of the distributors. It also recognized the consultancy's ideal network as a benchmark with which to regulate electricity distribution. This ideal network considered the structure of demand as being exogenously determined, its structure being governed by location, peak demand and type of voltage required. On this basis it proposed both an ideal network incorporating a high level of service quality, and a set of ideal input prices. The reason it proposed ideal input prices is that they are required to adjust the standard cost framework in order to set revised revenue caps.

The consultancy's ideal network has been controversial, and alternatives have been proposed by the distributor Unión Eléctrica Fenosa and by the Endesa group. The distributor Iberdrola claims that regulation using any ideal network presents such difficulties that it is better to reform the old revenue cap system, in the belief that any such network would be unfair to urban distributors and infeasible in light of environmental and zoning restrictions. This controversy has impeded the regulatory use of the ideal network ever since its adoption after the passage of the 1997 law. The consequence of this lack of agreement is that the regulator is using

Grifell-Tatjé, E. And C.A.K. Lovell (2003), "The Managers vs. the Consultants", *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

it, but in an unclear way. Nonetheless it has made Spain a pioneering country in regulating electricity distribution using an engineering benchmark grid rather than yardstick competition.[6]

As a consequence of this chain of events, we have access to a pair of data sets. One is contained in ATLAS, and describes the network as it existed in 1996. The other describes the consultancy's ideal engineering network. The former is the result of many years of managerial decisions based on growth in demand, a concomitant increase in market power, and continuing regulation based on economic incentives. The latter is the result of the consultancy's effort to design an ideal network from scratch, in light of current technology and current and projected future demand. The two differ substantially.

III. The Two Data Sets

Our actual data set describes the 1996 operations of nine distributors, each of which operates in one or more of 47 provinces. Allocating distributor operations to provinces generates a total of 68 distributor/province observations on which we base our analysis. We have excluded the island provinces of Canarias and Baleares, and we have deleted one atypical mainland distributor/province observation (Unión Eléctrica Fenosa's facility in the province of Lugo) because it provides electricity primarily to a single large aluminium producer, and its initial inclusion distorted the empirical results.

The data were provided to us by CSEN. The primary data source is ATLAS, which contains information on inputs and outputs at the distributor/province level. Additional detailed information concerning high voltage lines and substations was derived from alternative sources made available by CSEN. Service reliability information was obtained from the distributors' trade

Grifell-Tatjé, E. And C.A.K. Lovell (2003), "The Managers vs. the Consultants", *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

association. Finally, *MLE* contains information used to derive actual input prices. Based on consultations with CSEN, our variable list contains five outputs and five inputs. In order to conserve on degrees of freedom, several of these variables have been aggregated from more detailed information provided by CSEN. We first define the variables in general terms, and we then describe how the actual variables differ from the consultancy's ideal variables.

Outputs: low voltage electricity customers (#)
medium and high voltage electricity customers (#)
service territory area (km^2)
low, medium and high voltage electricity distributed (GWh)
service reliability [low and medium voltage electricity distributed (MWh) / low and medium voltage electricity lost to unplanned interruptions (MWh)]

Inputs: low voltage (< 0.38 KV) lines (km)
medium voltage ([0.38 KV, 36 KV]) lines (km)
high voltage ([36 KV, 132 KV]) lines (km)
substation transformer capacity from high voltage to high and medium voltage, and from medium voltage to medium voltage (MVA)
substation transformer capacity from medium voltage to low voltage (MVA)

The variable list is fairly conventional, although the inclusion of service territory area and service reliability among the outputs, and the disaggregation of the line and transformer capacity inputs, makes it more detailed than most variable lists.[7] The list does not contain a labor input, because labor expenses are embedded in the operating cost of the other inputs.

Actual and ideal outputs are the same, in both definition and magnitude. Actual inputs are available in ATLAS at the distributor/province level. Ideal inputs were calculated at the municipality and industrial area level, based on various indicators of electricity demand, and aggregated to the distributor/province level.

The *MLE* provides a framework for reimbursement based on an allowed "standard cost" for distributing high, medium and low voltage electricity. This is the only available source of

Grifell-Tatjé, E. And C.A.K. Lovell (2003), "The Managers vs. the Consultants", *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

operating cost information for the distribution of electricity. Since the framework has not been updated since 1987, the standard cost allowance probably overstates actual operating cost.

Our procedure for deriving actual input prices involves four steps, established in cooperation with CSEN. We first allocate standard operating cost associated with the distribution of medium and low voltage electricity from the distributor level to the distributor/province level, in the proportion of each activity accounted for by each province. We then allocate standard operating cost associated with the distribution of medium and low voltage electricity to the inputs associated with each activity, using cost allocation procedures developed in cooperation with CSEN. Once standard operating cost has been allocated to each input at the distributor/province level, we derive actual input prices by dividing input allocations by input quantities. These three steps generate distributor/province level prices for low voltage lines, medium voltage lines and substation transformer capacity from medium voltage to low voltage. Finally, we generate distributor/province level prices for the two remaining inputs from actual information on high voltage lines and high voltage substations. This information exists at the micro level, and does not have to be allocated from the distributor level to the distributor/province level.

The consultancy's ideal input prices are determined quite differently, from more detailed information. Their procedure begins with three types of operating cost: maintenance, repair and preparedness. Each includes labor cost, and each is defined at municipality or industrial areas. The first two cost components are defined on a per-unit basis for each input, and must be aggregated to the distributor/province level based on the ideal input vectors. The third cost component is defined at the distributor/province level, and must be allocated to inputs based on their expected failure frequencies. All three cost components vary across provinces, which have

Grifell-Tatjé, E. And C.A.K. Lovell (2003), "The Managers vs. the Consultants", *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

different operating environments. Once the first two cost components have been aggregated to the distributor/province level, and the third cost component has been allocated to inputs, ideal expenditure on each input is divided by ideal input quantities to derive ideal input prices.

The two data sets are summarized, for the nine distributors rather than for all 68 distributor/province observations, in Tables 1 - 3. Tables 1 and 2 illustrate the enormous size disparity among the distributors, as well as the dominance of the Endesa group (CSE, ENHER, ERZ, EV, FECSA and HECSA) and Iberdrola. Table 2 illustrates the difference between the actual network and the consultancy's ideal network. Aggregate resource use is lower for all five inputs in the consultancy's network. In only six instances does the consultancy recommend an increased use of a particular input.[8] Table 3 illustrates the difference between actual input prices and those proposed by the consultancy. The consultancy recommends average decreases in three input prices, and average increases in the prices of MV and HV lines. The pattern of recommended price changes is generally consistent across distributors, although there are a few exceptions.

In conjunction with the consultancy's smaller ideal network, its ideal input price structure implies that its ideal operating cost is 28% lower than the actual operating cost. Adoption of the consultancy's recommendations would have generated operating cost savings of nearly 300 million euros.[9]

Grifell-Tatjé, E. And C.A.K. Lovell (2003), "The Managers vs. the Consultants", *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

IV. The Analytical Framework

Let $x = (x_1,\ldots,x_N) \geq 0$ be a vector of inputs used in the production of a vector of outputs $y = (y_1,\ldots,y_M) \geq 0$, and let $w = (w_1,\ldots,w_N) > 0$ be a vector of input prices. Cost is then $w^T x \geq c(y,w)$, where $c(y,w)$ is a cost frontier characterizing the minimum cost required to produce outputs y when input prices are w.

We designate the actual situation confronted by the managers with superscript "^{o}" and the benchmark situation designed by the consultancy with superscript "*". Then $w^{oT}x^o \geq c^o(y,w^o)$ and $w^{*T}x^* \geq c^*(y,w^*)$, where $c^o(y,w^o)$ embodies the actual network and input prices and $c^*(y,w^*)$ embodies the consultancy's ideal network and input prices.

In addition to the two cost frontiers $c^o(y,w^o)$ and $c^*(y,w^*)$, in order to decompose the cost differential $(w^{oT}x^o - w^{*T}x^*)$ we need a pair of hypothetical cost frontiers $c^o(y,w^*)$ and $c^*(y,w^o)$. The former describes the best the managers can do with their actual network and the consultancy's ideal input prices, and the latter describes the best the consultancy can do with its ideal network and the managers' actual input prices. Since the managers and the consultancy face the same output demands, we do not attach a superscript to y in any of the four cost frontiers.

The four cost frontiers are depicted in Figure 1. The actual cost frontier $c^o(y,w^o)$ is the highest, and observed cost $w^{oT}x^o > c^o(y,w^o)$. The consultancy's cost frontier $c^*(y,w^*)$ is the lowest, and the consultancy's cost $w^{*T}x^* > c^*(y,w^*)$. The two hypothetical cost frontiers $c^o(y,w^*)$ and $c^*(y,w^o)$ are located in the middle, in no particular order. Our objective is to decompose the cost differential $(w^{oT}x^o - w^{*T}x^*)$ in an economically informative way. We have two options, as indicated in Decompositions 1 and 2.

Grifell-Tatjé, E. And C.A.K. Lovell (2003), “The Managers vs. the Consultants”, *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

Decomposition 1. The cost differential ($w^{oT}x^o - w^{*T}x^*$) decomposes as

$$(w^{oT}x^o - w^{*T}x^*) =$$

$$[c^o(y,w^o) - c^*(y,w^o)] \qquad \textbf{network design differential}$$

$$+ [c^*(y,w^o) - c^*(y,w^*)] \qquad \textbf{input price differential}$$

$$+ \{[w^{oT}x^o - c^o(y,w^o)] - [w^{*T}x^* - c^*(y,w^*)]\} \qquad \textbf{cost efficiency differential}$$

Decomposition 2. The cost differential ($w^{oT}x^o - w^{*T}x^*$) also decomposes as

$$(w^{oT}x^o - w^{*T}x^*) =$$

$$[c^o(y,w^*) - c^*(y,w^*)] \qquad \textbf{network design differential}$$

$$+ [c^o(y,w^o) - c^o(y,w^*)] \qquad \textbf{input price differential}$$

$$+ \{[w^{oT}x^o - c^o(y,w^o)] - [w^{*T}x^* - c^*(y,w^*)]\} \qquad \textbf{cost efficiency differential}$$

In Figure 1 $c^o(y,w^o) = w^{oT}x^B$, $c^*(y,w^*) = w^{*T}x^E$, $c^*(y,w^o) = w^{oT}x^F$ and $c^o(y,w^*) = w^{*T}x^G$. Thus the cost decomposition exercise requires invoking Shephard's (1953) lemma to retrieve the unobserved cost-efficient input vectors $x^B = \nabla_{wo}c^o(y,w^o)$ and $x^E = \nabla_{w*}c^*(y,w^*)$, and either the hypothetical input vector $x^F = \nabla_{wo}c^*(y,w^o)$ in Decomposition 1 or the hypothetical input vector $x^G = \nabla_{w*}c^o(y,w^*)$ in Decomposition 2.

The two decompositions identify the same three sources of cost difference. The first component attributes a portion of the cost differential to differences in network design; the consultancy's ideal network may be less costly to operate at either input price vector. The second component attributes a portion of the cost differential to input price differences; the consultancy's ideal input price vector may lead to lower cost regardless of which distribution network is used. The third component attributes the remainder of the cost differential to differences in cost efficiency; since the consultancy has simultaneously designed both an ideal network and an ideal

Grifell-Tatjé, E. And C.A.K. Lovell (2003), "The Managers vs. the Consultants", *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

input price vector, this combination may be more cost efficient than that of the incumbent managers.

The two decompositions share a common cost efficiency differential, but they have different network design and input price differentials because they are based on different hypothetical cost frontiers. The first decomposition evaluates the network design differential at the managers' input vector w^o, and evaluates the input price differential using the consultancy's network $c^*(\bullet)$. The second decomposition evaluates the network design differential at the consultancy's input vector w^*, and evaluates the input price differential using the managers' network $c^o(\bullet)$.

We expect the two network design differentials to be similar, and the two input price differentials to be similar. However the conditions under which $c^*(y,w^o) = c^o(y,w^*)$ (which would make both differentials coincide) are restrictive, and are unlikely to be satisfied empirically. Accordingly it is useful to combine the two decompositions and express the combination in arithmetic mean form, as indicated in Decomposition 3.[10]

Decomposition 3. The cost differential $(w^{oT}x^o - w^{*T}x^*)$ decomposes in arithmetic mean form as

$$
\begin{aligned}
(w^{oT}x^o - w^{*T}x^*) = {} & \\
& (1/2)\{[c^o(y,w^o) - c^*(y,w^o)] + [c^o(y,w^*) - c^*(y,w^*)]\} && \textbf{network design differential} \\
& + (1/2)\{[c^*(y,w^o) - c^*(y,w^*)] + [c^o(y,w^o) - c^o(y,w^*)]\} && \textbf{input price differential} \\
& + \{[w^{oT}x^o - c^o(y,w^o)] - [w^{*T}x^* - c^*(y,w^*)]\} && \textbf{cost efficiency differential}
\end{aligned}
$$

In contrast to Decompositions 1 and 2, the mean form Decomposition 3 is based on all four cost frontiers, and so it requires finding all four unobserved cost-efficient input vectors identified in Figure 1 and defined beneath Decomposition 2. However the mean form decomposition has

Grifell-Tatjé, E. And C.A.K. Lovell (2003), “The Managers vs. the Consultants”, *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

two nice features. As a practical matter, it avoids having to choose between the two hypothetical cost frontiers $c^*(y,w^o)$ and $c^o(y,w^*)$. From a theoretical perspective, its input price differential component is the arithmetic mean of a pair of Konüs (1924) input price (or cost of living) indexes, one using the managers' network and the other using the consultancy's ideal network. Thus the mean form decomposition has an attractive theoretical foundation.[11,12]

V. The Empirical Technique

Decomposing the cost differential requires finding the four unobserved cost-efficient input vectors (x^B,x^E,x^F,x^G), which requires solving four cost minimization problems. We use linear programming techniques described in Färe, Grosskopf and Lovell (1985) to do so. The general form of these four linear programming problems is

$$\begin{array}{lll} & \min_{x,\lambda}\ w^{iT}x & \\ \text{subject to} & y^i_m \leq \Sigma_j\lambda_j y_m^j & m = 1,\ldots,M \\ & x_n \geq \Sigma_j\lambda_j x_n^j & n = 1,\ldots,N \\ & \lambda_j \geq 0 & j = 1,\ldots,J \\ & \Sigma_j\lambda_j = 1, & \end{array}$$

where the superscript “i” indicates the producer being evaluated and there are J producers in the sample. In our application M = 5, N = 5, and J = 68. The production technology constructed by the constraints in the program satisfies monotonicity and convexity, and allows for variable returns to scale.

The solution to the problem identifies a cost minimizing input vector for producer i facing input prices w^i and constrained by best practice technology as established by the constraints in the program. When the data are the managers' data (y,x^o,w^o), the solution to the problem is x^B in

Grifell-Tatjé, E. And C.A.K. Lovell (2003), “The Managers vs. the Consultants”, *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

Figure 1, and $c^o(y,w^o) = w^{oT}x^B$ in Decomposition 3. When the data are the consultancy's data (y,x^*,w^*), the solution to the problem is x^E in Figure 1, and $c^*(y,w^*) = w^{*T}x^E$ in Decomposition 3. The input vector x^F in Figure 1, for which $c^*(y,w^o) = w^{oT}x^F$ in Decomposition 3, is determined as the solution to the problem when the data are (y,x^*,w^o) and contain the consultancy's input vector and the managers' input price vector. Finally the input vector x^G in Figure 1, for which $c^o(y,w^*) = w^{*T}x^G$ in Decomposition 3, is determined as the solution to the problem when the data are (y,x^o,w^*) and contain the managers' input vector and the consultancy's input price vector. Identification of (x^B,x^E,x^F,x^G) for each producer in each scenario enables us to implement the cost differential decomposition in Decomposition 3.

VI. The Empirical Findings

We have solved the four linear programming problems for each of the 68 distributor/province observations. The solutions to these four sets of problems generate values of the four cost-efficient input vectors (x^B,x^E,x^F,x^G) required to implement the cost differential decomposition in Decomposition 3. Our empirical findings appear in Table 4, which summarizes the decomposition by distributor rather than by distributor/province observation.[13]

The final three rows of Table 3 demonstrate that the actual network operates at a cost that is nearly 300 million euros, or nearly 40%, higher than the cost of operating the consultancy's ideal network. Thus the consultancy's ideal network has the potential to achieve a 28% cost saving. This cost saving is widespread, and applies to the seven largest distributors. It is this potential cost saving that we wish to decompose into its constituent sources.

Grifell-Tatjé, E. And C.A.K. Lovell (2003), “The Managers vs. the Consultants”, *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

Table 4 demonstrates that 69% of the potential cost saving is attributable to the fact that the consultancy proposes lower input prices, in the aggregate and for the seven largest distributors. 49% of the potential cost saving is due to the fact that the consultancy proposes a leaner network, in the aggregate and for all nine distributors. Neither of these findings is surprising, since the consultancy's engineers were unencumbered by history. The consultancy’s network was designed solely on the basis of current and projected future demand, and without the structural constraints imposed by past developments, while much of the actual network was built years ago before demand evolved to its current level and geographic distribution. It is noteworthy, however, that these two sources exceed the total cost saving.

It follows that the consultancy’s ideal network is not as cost efficient as the actual network. This gives the managers a countervailing 18% cost advantage, amounting to 53 million euros, over the consultancy. The superior cost efficiency of the actual network is widespread, applying to seven of nine distributors. There are at least two plausible explanations for the superior cost efficiency of the actual network. First, the consultancy’s network was designed by engineers rather than by economists, and while the engineers developed a superior network design, they were less concerned with its cost efficiency. With this in mind, Gómez and Pacheco (2000) and GERE (2000) have proposed a revision of the engineering procedure used to build the ideal network. Second, the standard cost reimbursement scheme allows managers to retain excess revenues, and the standard cost parameters have not been adjusted for improvements in productivity since 1987. This provides managers with a powerful incentive to be cost efficient. Superior allocative efficiency gained through years of managerial experience is the driving

Grifell-Tatjé, E. And C.A.K. Lovell (2003), “The Managers vs. the Consultants”, *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008
source behind both of these explanations, since the two networks have essentially the same technical efficiency.

VII. Conclusions

We have exploited an unusual opportunity to benchmark the managers’ performance against engineering standards established by an international consultancy. The usual practice is to benchmark against best observed practice, because engineering information is rarely available. The distinction is important, because the consultancy’s network was designed solely on the basis of currently available technology and current and projected future demand, and without the structural constraints imposed by outdated technology and past developments, while much of the existing network was built years ago before technology advanced and demand evolved to its current level and geographic distribution.

Our actual performance describes the 1996 activities of Spanish electricity distributors, for which we have a total of 68 distributor/province observations. Our engineering standards are obtained by aggregating detailed information generated by the consultancy to the same distributor/province level.

As expected, we find that the network design differential and the input price differential both favor the consultancy's ideal network. However since the ideal network was designed by engineers rather than by economists, we also find that the incumbent managers are more cost-efficient than the consultants because they exploit their incentive to be allocatively efficient under the revenue cap regulatory regime. Since the ideal network does not allocate inputs in a

Grifell-Tatjé, E. And C.A.K. Lovell (2003), “The Managers vs. the Consultants”, *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

cost-efficient manner, we conclude that the consultancy has understated the potential cost savings by nearly one-third.

Nonetheless the consultancy's ideal network has the potential to serve the regulator well, as a substitute for yardstick competition in a market supplied by so few distributors that implementing yardstick competition would require the introduction of international comparators of dubious relevance. We find that the regulator is achieving part of this potential. The regulator is using it to justify a reallocation of the aggregate revenue cap among distributors. However there is little evidence to suggest that the regulator is also using it to reallocate monopoly rents away from distributors toward consumers by setting a positive X so as to reduce the aggregate revenue cap.

Grifell-Tatjé, E. And C.A.K. Lovell (2003), “The Managers vs. the Consultants”, *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

Footnotes

* Previous versions of this paper have been presented at the Sixth European Workshop on Efficiency and Productivity Analysis held at KVL, Copenhagen, Denmark, at Aston Business School, Birmingham, UK, and at the Australasian Meetings of the Econometric Society, Queensland University of Technology, Brisbane, Australia. We are grateful to Comisión Nacional de la Energía (CNE), Generalitat de Catalunya 200SGR00052, and Dirección General de Enseñanza Superior e Investigación Científica, SEC2001-2793-C03-01, for generous financial support. We thank Luis Maqueda and Arturo Romero of CNE for their assistance, Peter Bogetoft for his guidance, and Steinar Holden and two referees for their constructive comments.

1. In an academic setting, DEA has been used to investigate the performance of electricity distributors in a number of countries, including Norway by Førsund & Kittelsen (1998), and Sweden by Hjalmarsson & Veiderpass (1992a,1992b). In a regulatory setting, Agrell & Bogetoft (2001) report that DEA has been proposed or is in use in a number of countries. The Norwegian and Finnish experiences are described by Kittelsen (1999) and Korhonen and Syrjänen (2002).

2. Sample sizes are relatively large in Finland, Norway and Sweden, but relatively small in Denmark, the Netherlands and New Zealand. In Australia, where regulation is conducted at the state level, sample sizes are extremely small, and the inclusion of overseas distributors for benchmarking purposes has been controversial; see ESAA (1994), IPART (2001), REGGEN (1998) and QCA (1999).

3. The Swedish Energy Agency (2002) describes the ongoing construction of what it calls a “fictitious” grid with which to calculate resource requirements for the efficient distribution of electricity at high reliability and reasonable tariffs. Fictitious line lengths and substation

Grifell-Tatjé, E. And C.A.K. Lovell (2003), “The Managers vs. the Consultants”, *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

capacities are to be combined with cost functions for each part of the grid. This grid is intended to provide incentives to the grid companies to operate as effectively as possible, and to provide the regulator with a benchmark against which to assess the performance of the grid companies and the reasonableness of their tariffs.

4. Much of the material in this Section is based on discussions with CNE personnel. Arocena, Kühn & Regibeau (1999) provide additional information, and Crampes & Laffont (1995) explore the relationship of MLE to yardstick competition.

5. CSEN has been renamed twice since 1994. The present name is “Comisión Nacional de la Energía” (CNE). We retain the original name in the paper. CSEN was given a limited role in the reform process, with the Ministerio de Industria retaining primary decision-making authority until it disappeared after the parliamentary elections of 1999. In its place there is a new ministry.

6. Since 1998 the regulator has issued an aggregate revenue cap that is divided among the electricity distributors. This allocation is based on shares that are, in theory, calculated using the ideal network. In fact, they are very close to shares that can be calculated from the information on ideal cost in Table 3. But it is unclear how the figure issued by the regulator is calculated. It seems that the regulator is using the old revenue cap system to calculate it, but it is difficult to say because there is no information about it. As we show in this paper, full implementation of the ideal network would generate a significant reduction in the cost of electricity distribution.

7. Spanish law defines the transmission activity as involving lines transmitting at least 220 KV. Our distribution lines distribute no more than 132 KV. However since high voltage substations must be capable of transforming voltages above 132KV, we define the first substation input in terms of the capacity to transform high voltage (400KV, 220KV or 132KV) to a lower high

Grifell-Tatjé, E. And C.A.K. Lovell (2003), "The Managers vs. the Consultants", *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

voltage (132KV, 66KV or 50KV), in terms of the capacity to transform high voltage (132KV, 66KV, 50KV or 45KV) to medium voltage as defined for lines, and in terms of the capacity to transform medium voltage to a lower medium voltage as defined for lines. We define the second substation input in terms of the capacity to transform medium voltage to low voltage, both as defined for lines.

8. The one glaring anomaly is $x_1^o > x_1^*$ for CSE. According to CNE personnel, this reflects the fact that CSE serves Andalusia, where large property developers have installed their own low voltage lines. These do not appear in the actual input vector, but they are included in the consultancy's ideal input vector. Although it would be desirable to adjust either x_1^o or x_1^*, the requisite information is unavailable.

9. It is worth noting that the standard operating cost of 1,048 million euros we are examining is just over one third of standard total cost allocated to the distributors.

10. It is also possible to express Decomposition 3 in geometric mean form as

$$(w^{oT}x^o / w^{*T}x^*) =$$

$$\{[c^o(y,w^o) / c^*(y,w^o)] \times [c^o(y,w^*) / c^*(y,w^*)]\}^{1/2} \qquad \textbf{network design ratio}$$

$$\times \{[c^*(y,w^o) / c^*(y,w^*)] \times [c^o(y,w^o) / c^o(y,w^*)]\}^{1/2} \qquad \textbf{input price ratio}$$

$$\times [w^{oT}x^o / c^o(y,w^o)] / [w^{*T}x^* / c^*(y,w^*)] \qquad \textbf{cost efficiency ratio}$$

Details and empirical calculations are available on request.

11. For more on the Konüs price index and related matters, see Balk (1998).

12. It is also possible to decompose the cost efficiency differential into a technical efficiency differential and an allocative efficiency differential. Such a further decomposition has the

Grifell-Tatjé, E. And C.A.K. Lovell (2003), “The Managers vs. the Consultants”, *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

potential to shed light on the nature of the cost efficiency differential, since cost inefficiency decomposes into technical inefficiency (an equiproportionate excess use of all inputs) and allocative inefficiency (a misallocation of inputs in light of their respective prices). We do not report results of this decomposition, although results are available on request.

13. Decompositions 1 and 2 produce very similar results, and so the arithmetic mean form decomposition in Decomposition 3 is not averaging disparate results.

Grifell-Tatjé, E. And C.A.K. Lovell (2003), “The Managers vs. the Consultants”, *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

References

Agrell, P. and P. Bogetoft (2001), Should Regulators Use DEA?, KVL, Copenhagen, Denmark.

Arocena, P. Kühn, K.-U. and Regibeau, P. (1999), Regulatory Reform in the Spanish Electricity Industry: A Missed Opportunity for Competition, *Energy Policy* 27, 387-99.

Balk, B. M. (1998), *Industrial Price, Quantity and Productivity Indexes: The Micro-Economic Theory and an Application*. Kluwer Academic Publishers, Boston, MA.

Crampes, C. and Laffont, J.-J. (1995), Transfers and Incentives in the Spanish Electricity Sector, *Revista Española de Economía* 2, 117-40.

Electricity Supply Association of Australia (ESAA) (1994), *International Performance Measurement for the Australian Electricity Supply Industry 1990-1991*, ESAA, Sydney.

Färe, R. Grosskopf, S. and Lovell, C. A. K. (1985), *The Measurement of Efficiency of Production*, Kluwer-Nijhoff Publishing, Boston, MA.

Førsund, F. R. and Kittelsen, S. A. C. (1998), Productivity Development of Norwegian Electricity Distribution Utilities, *Resource and Energy Economics* 20, 207-224.

Gómez, T. and Peco, J. (2000), A Model for Planning Large Scale MV Networks Considering Uncertainty in Reliability Modeling, University of Comillas, Spain.

Grupo de Electrónica y Redes Electricas (GERE) (2000), Planificación de Redes de Energía Electrica, University of Vigo, Spain.

Hjalmarsson, L. and Veiderpass, A. (1992a), Productivity in Swedish Electricity Retail Distribution, *Scandinavian Journal of Economics*, 94 Supplement, 193-105.

Grifell-Tatjé, E. And C.A.K. Lovell (2003), "The Managers vs. the Consultants", *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.
DOI: 10.1111/1467-9442.00008

Hjalmarsson, L. and Viederpass, A. (1992b), Efficiency and Ownership in Swedish Electricity Retail Distribution, *Journal of Productivity Analysis* 3, 7-23.

Independent Pricing and Regulatory Tribunal of New South Wales (IPART) (2001), *Form of Economic Regulation for NSW Electricity Network Charges*. http://www.ipart.nsw.gov.au.

Kittelsen, S. A. C. (1999), Using DEA to Regulate Norwegian Electricity Distribution Utilities, 6th European Workshop on Efficiency and Productivity Analysis, KVL, Copenhagen, Denmark.

Konüs, A. A. (1924), The Problem of the True Index of the Cost of Living, translated in *Econometrica* 7 (1939), 10-29.

Korhonen, P. and Syrjänen, M. (2002), Evaluation of Cost Efficiency in Finnish Electricity Distribution, Working Paper W-305, Helsinki School of Economics, Helsinki, Finland.

Netherlands Electricity Regulatory Service (DTE) (2000), *Choice of Model and Availability of Data for the Efficiency Analysis of Dutch Network and Supply Businesses in the Electricity Sector*. http://www.dte.nl.

Office of the Regulator General, Victoria (REGGEN) (1998), *2001 Electricity Distribution Price Review: Framework and Approach*. http://www.reggen.vic.gov.au.

Queensland Competition Authority (QCA) (1999), *Electricity Distribution: Framework for Regulation*. http://www.qca.org.au.

Shephard, R. W. (1953), *Cost and Production Functions*. Princeton University Press, Princeton, NJ.

Swedish Energy Agency (2002), *Network Regulation*. http://www.stem.se.

TABLE 1. Output Quantities for Spanish Electricity Distributors									
	Electricity Distributors								
	CSE	ENHER	ERZ	EV	FECSA	HECSA	HC	IB	UEF
Y_1 Number consumers,LV	3,425,337	1,075,904	646,787	509,957	1,820,524	545,331	485,949	7,804,648	2,639,833
Y_2 Number consumers, MV & HV	6,590	939	2,380	592	1,120	355	525	33,884	7,132
Y_3 Service territory area, Km^2	99,616	16,282	43,064	18,432	18,806	5,845	7,565	207,243	69,433
Y_4 LV, MV&HV Electricity distributed, GWh	19,910	10,956	4,420	3,601	14,479	4,008	6,239	53,706	17,367
Y_5 Reliability	523.6	495.2	594.8	826.8	499.1	970.8	1,009.5	1,304.0	426.1

CSE = Compañíá Sevillana de Electricidad, S. A.
ENHER = Energia Nacional Hidroeléctrica del Ribagorzana
ERZ = Eléctricas Reunidas de Zaragoza, S. A.
EV = Electra de Viesgo, S. A.
FECSA = Fuerzas Eléctricas de Cataluña, S. A.
HECSA = Hidroeléctrica del Cantábrico, S. A.
HC = Hidroeléctrica del Catanuña, S. A.
IB = Iberdrola, S. A.
UEF = Unión Eléctrica Fenosa, S. A.

Grifell-Tatjé, E. And C.A.K. Lovell (2003), "The Managers vs. the Consultants", *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.

DOI: 10.1111/1467-9442.00008

TABLE 2. Input Quantities for Spanish Electricity Distributors

	Electricity Distributors								
Actual Inputs	CSE	ENHER	ERZ	EV	FECSA	HECSA	HC	IB	UEF
x^O_1 LV lines in Km	27,770	15,336	9,001	15,278	27,933	4,739	10,065	100,709	47,133
x^O_2 MV lines in Km	35,925	9,920	10,144	7,994	20,406	3,728	4,657	71,924	29,901
x^O_3 HV lines in Km	9,135	1,993	3,056	1,741	2,956	1,077	1,214	16,853	6,814
x^O_4 Substation transformer capacity: HV/HV, HV/MV, MV/MV, in MVA	19,505	7,636	4,879	3,605	10,247	3,863	3,958	66,042	15,752
x^O_5 Substation transformer capacity: MV/LV, in MVA	10,105	4,332	1,566	1,336	6,148	2,100	915	17,206	5,976
"Ideal" Inputs									
x^*_1 LV lines in Km	48,483	12,694	6,730	9,519	17,355	3,600	8,184	94,288	39,769
x^*_2 MV lines in Km	32,602	6,454	9,259	7,183	8,644	2,837	6,673	67,549	30,412
x^*_3 HV lines in Km	6,046	1,143	2,574	828	1,131	399	620	13,748	4,232
x^*_4 Substation transformer capacity: HV/HV, HV/MV, MV/MV, in MVA	15,218	6,654	5,597	2,809	12,194	3,747	3,406	45,501	16,125
x^*_5 Substation transformer capacity: MV/LV, in MVA	6,892	2,672	1,525	1,012	4,949	1,403	1,030	16,225	5,857

Grifell-Tatjé, E. And C.A.K. Lovell (2003), "The Managers vs. the Consultants", *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.

DOI: 10.1111/1467-9442.00008

TABLE 3. Input Prices and Total Operating Cost for Spanish Electricity Distributors

	Electricity Distributors									
Actual Input Prices	**CSE**	**ENHER**	**ERZ**	**EV**	**FECSA**	**HECSA**	**HC**	**IB**	**UEF**	
w^O_1 euros by Km LV	1,689	1,198	638	282	709	1,231	546	890	739	
w^O_2 euros by Km MV	976	1,164	552	446	803	1,426	1,044	980	878	
w^O_3 euros by Km HV	1,063	1,127	1,040	1,089	1,248	1,224	981	1,080	1,140	
w^O_4 euros by MVA	2,058	2,639	3,413	2,490	2,675	2,954	1,468	2,402	2,717	
w^O_5 euros by MVA	3,739	4,515	3,812	3,525	5,766	5,714	5,856	5,610	5,730	
"Ideal" Input Prices										
w^*_1 euros by Km LV	883	955	943	721	883	1,039	920	894	875	
w^*_2 euros by Km MV	1,542	1,549	1,596	1,521	1,523	1,587	1,673	1,538	1,510	
w^*_3 euros by Km HV	1,789	1,773	1,737	1,731	1,791	1,811	1,874	1,757	1,700	
w^*_4 euros by MVA	842	814	861	800	832	678	524	789	654	
w^*_5 euros by MVA	3,379	3,061	3,488	5,245	3,497	3,344	4,833	3,270	3,649	
Total Operating Cost (*millions* euros)	**CSE**	**ENHER**	**ERZ**	**EV**	**FECSA**	**HECSA**	**HC**	**IB**	**UEF**	**TOTAL**
Actual Cost = $w^O x^O$	162.9	76.8	39.4	21.8	118.8	38.9	22.7	423.5	143.4	1,048.2

Grifell-Tatjé, E. And C.A.K. Lovell (2003), "The Managers vs. the Consultants", *The Scandinavian Journal of Economics* vol. 105, issue 1, pages 119 – 138.

DOI: 10.1111/1467-9442.00008

"Ideal" Cost = w^*x^*	139.5	37.9	34.9	26.7	57.3	17.0	26.6	296.2	113.8	749.9
$w^Ox^O - w^*x^*$	23.4	38.9	4.4	-4.8	61.5	21.9	-3.9	127.3	29.6	298.3

TABLE 4. Cost Differential Decomposition for Spanish Electricity Distributors (million euros)

Electricity Distributors	Number of Provinces	$w^o x^o$ - $w^* x^*$	=	Network Design Differential	+	Input Price Differential	+	Cost Efficiency Differential	=	Actual Cost Inefficiency	"Ideal" Cost Inefficiency
CSE	9	23.4		13.8		26.0		-16.4		21.6	38.0
ENHER	7	38.9		14.7		20.6		3.6		9.4	5.8
ERZ	4	4.4		4.2		2.3		-2.1		2.4	4.6
EV	5	-4.8		3.1		-5.0		-2.9		8.0	10.9
FECSA	4	61.5		27.6		34.1		-0.2		11.4	11.6
HECSA	4	21.9		7.3		10.7		4.0		7.3	3.4
HC	1	-3.9		1.9		-0.9		-4.9		0.0	4.9
IB	25	127.3		50.9		89.8		-13.4		25.2	38.6
UEF	9	29.6		22.0		28.3		-20.7		17.4	38.2
TOTAL	68	298.3		145.5		205.9		-53.1		102.7	155.9

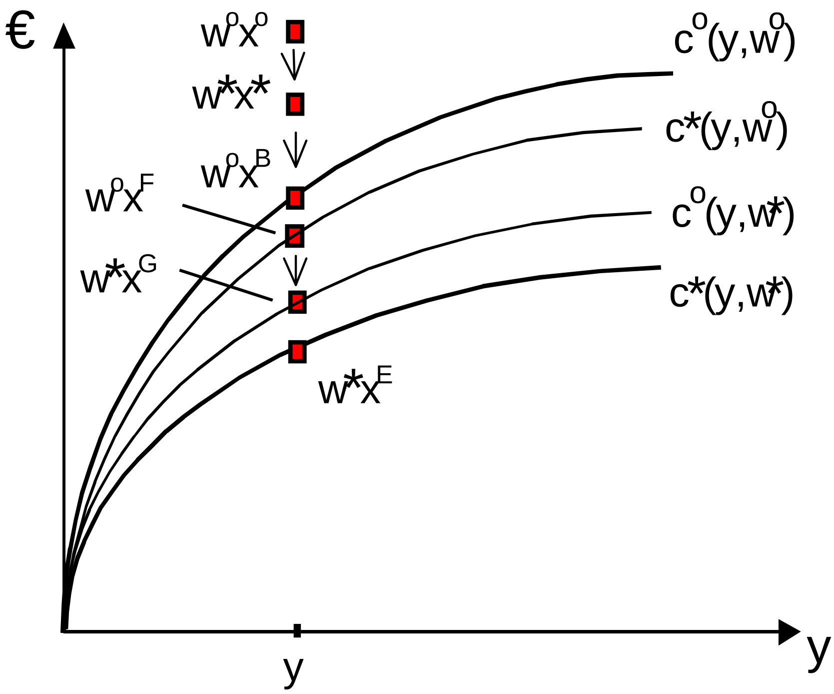

Figure 1. The Cost Decomposition Framework